Facial Feature Extraction Based on the Smallest Univalence Segment Assimilating Nucleus (SUSAN) Algorithm

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Overview

- Motivation
- Problem
- Approach
- Algorithm
- Results
- Summary
Motivation (1)

- Model-based coding
Motivation (2)

- At the beginning of the image sequence, the model must be adapted to the real face:
  - Face segmentation
  - Facial feature extraction
    - i.e. eyes and mouth corners,
    - Chin and cheek borders
  - Face model adaptation
Motivation (3)

- Face segmentation
  - The face is segmented splitting the object silhouette into head and shoulders and then removing the upper third of the head.
  - The silhouette is estimated by a change detection algorithm.
Motivation (4)

- Artificial template matching for eyes and mouth corners extraction
Motivation (5)

- Deformable Template Matching for chin and cheek borders extraction
Problem

- Artificial template matching fails when applied to images different than those used to generate the artificial templates

- Parabolas are not flexible enough for description of chin and cheek borders
Approach

- First, all corners and borders are extracted using the Smallest Univalue Segment Assimilating Nucleus (SUSAN) algorithm

- Then, the facial features are detected from the extracted corners and borders by using knowledge based rules
Corner and border extraction

- Smallest Univalue Segment Assimilating Nucleus (SUSAN) algorithm

\[ n = \text{USAN area} \]

- If \( n \approx n \cdot r^2 \cdot \frac{1}{2} \) → straight border
- If \( n \ll n \cdot r^2 \cdot \frac{1}{2} \) → corner
Algorithm (1)

- Extraction of the mouth corners and outer corners of the eyes

![Diagram of SUSAN detection regions from object silhouette]
Algorithm (2)

- Detection of the left mouth corner (example)

Knowledge-based rules

- Eliminate corners where \( a/b > 0.35 \)
- Eliminate corners with higher border concentration to their left than to their right
- Select the corner located most to the left
Algorithm (3)

- Extraction of the nose corners

search region from extracted mouth corners and outer corners of the eyes
Algorithm (4)

- Extraction of the chin and cheek borders

search region from object silhouette and extracted mouth corners and outer corners of the eyes
Results (1)

- Data:
  - 40 frames of test sequence Claire (CIF, 10 Hz)

- Average processing time:
  - 0.2 sec/frame

- Reliability:
  - all facial features could be extracted in 85% of the frames
Results (2)

4th frame, Claire

7th frame, Claire

12th frame, Claire

14th frame, Claire

17th frame, Claire

29th frame, Claire
Results (3)

- Position error of the mouth corners and outer corners of the eyes: 2.3 ± 0.9 pixels
- Position error of the nose corners: 3.7 ± 1.9 pixels
- Position error of the chin and cheek borders: 1.1 ± 0.8 pixels
Summary

• First, all corners and borders are extracted using the SUSAN algorithm

• Second, the facial features are detected from the extracted corners and borders using knowledge-based rules

• All facial features were extracted in 85% of the frames